IMAGE COMPARISON APPARATUS, IMAGE COMPARISON METHOD, IMAGE COMPARISON CENTER APPARATUS, AND IMAGE COMPARISON SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to an image comparison apparatus for photographing, for example, a face of a person and making a comparison and a check, and more particularly to an image comparison apparatus, an image comparison method, an image comparison center apparatus, and an image comparison system, in which photographed information of the same object is enhanced and check accuracy can be improved.

2. Description of the Related Art:

In general, in this kind of image comparison apparatus, a face image of a check object person, acquired by using a camera, is checked against previously registered registration images so that the check object person in question is confirmed.

For example, in the case where the image comparison apparatus is applied to a gate function for managing entrance into and exit from a room, as shown in Fig. 7, an illumination device 72, a camera 73, a person detection sensor 74, and a photograph start check button 75, which constitute an image comparison apparatus 71, are attached to a door 76 or a wall surface in the vicinity of the door.

In the case where a check object person 77 enters or exits

1

from a room by using this image comparison apparatus 71, when the check object person 77 stops at a check position and presses down the check button 75, photographing of the face of the check object person 77 approaching the camera 73 is started in connection with this, and the photographed face image is compared with the previously registered face image of the check object person to check and confirm consistence/inconsistence, and on the basis of this, the entrance and exit is permitted or the entrance and exit is restricted.

In this case, as shown by an image information acquisition curve 81 of Fig. 8, at the timing when the check object person stops at the check position suitable for photographing of the camera and presses down the check button, the face image of the check object person can be obtained most accurately. On the other hand, there is known that as the check object person goes away from the position of the check button, it becomes hard to accurately grasp the face image of the check object person, and there is a tendency that the stability of image information is lowered.

By the way, when the check button is pressed down, in the case of such an expression that the check object person closes the eyes, opens the mouth, or looks away, since the face image is different from the registered image, even if the check object person is the person in question, it is judged that the face image is a check poor image and a recheck operation

2

has been again repeated.

This recheck operation is repeated till the number of operations reaches the number of predetermined retry times, and if check confirmation can not yet be made, an input operation using a personal identification key or readout using a check card has been carried out.

However, in this case, the number of retry operations is increased because of the recheck, or it takes labor to make a check operation, so that the convenience to the check object person entering or exiting from a room is lowered, and further, a smooth use can not be realized, as in the case that for example, it takes a processing time or the use at the entrance and exit is delayed by check waiting.

SUMMARY OF THE INVENTION

The present invention is therefore to provide an image comparison apparatus, an image comparison method, an image comparison center apparatus, and an image comparison system, which has a high check function in which when an image of a photograph object is acquired, images of the photograph object are suitably acquired not only from an image acquired when a button for check confirmation is pressed down, but also from a plurality of images before that, and check confirmation can be made.

According to an aspect of the present invention, an image

3

comparison apparatus in which an image of a photograph object is acquired by using photograph means, and in a case where a button for check confirmation is pressed down, the acquired image is compared with information concerning previously memorized registration images, and a comparison result is outputted, the image comparison apparatus characterized in that an object detection sensor for detecting existence of the photograph object is provided, the photograph means acquires a plurality of images of the photograph object during a period from detection of the photograph object by the object detection sensor to a press of the button, and in a case where the button is pressed, at least one of the plurality of acquired images is compared with the information concerning the previously memorized registration image.

As a result, even if a check poor image is produced at the time of check of the photograph object when the button for check confirmation is pressed down, since the check can be made by using a complementary image obtained at the timing before that, the image suitable for check judgment of the photograph object can always be ensured at the time of check, a recheck operation is omitted, and a check processing can be carried out in a short time. For example, in the case where the apparatus is applied to an entrance and exit use of a photograph object person, even if the acquired image is judged to be a check poor image since an expression of a face is much

4

changed from a normal one, for example, a mouth is opened or eyes are closed, since the check can be made by using the images before that, an accurate check judgment can be ensured, and an efficient check operation can be made in a short time.

According to another aspect of the present invention, an image comparison method comprises a step of detecting existence of a photograph object, a step of capturing a plurality of images of the photograph object in a case where the photograph object is detected, a step of detecting a press of a button for check confirmation, a step of comparing at least one of the plurality of captured images with information concerning previously memorized registration images when the press of the button is detected, and a step of outputting a comparison result.

If the photograph object is checked by the procedure of such comparison and check steps, even if a suitable check image is not obtained at the point of time when the button for check confirmation is pressed down, the check confirmation can be made by using another image, so that it becomes unnecessary to repeatedly press down the button, and a check processing can be completed by one press operation of the button.

According to another aspect of the present invention, an image comparison center apparatus compares a captured image with information concerning registration images previously memorized in memory means, and outputs a comparison result,

in which the image comparison center apparatus is characterized in that a plurality of captured images of a same object are successively compared with information concerning the registration images memorized in the memory means, and as a result of the comparison, a proper judgment result is outputted in a case where there is a similar image satisfying a check judgment threshold, and an improper judgment result is outputted in a case where there is no similar image satisfying the check judgment threshold in the plurality of images.

In this case, if there is a similar image satisfying the check judgment threshold in the plurality of photographed images, the proper judgment result is outputted, and if there is no similar image satisfying the check judgment threshold, the improper judgment result is outputted, so that the plurality of images concerning the same object are used on a screen for check judgment, and check confirmation with high accuracy can be made.

According to still another aspect of the present invention, an image comparison system captures an image of a photograph object by using photograph means, compares the captured image with information concerning registration images previously memorized in memory means, and outputs a comparison result, in which the image comparison system is characterized in that a plurality of captured images of a same object are successively compared with the information concerning the registration

6

images memorized in the memory means, and as a result of the comparison, a proper judgment result is outputted in a case where there is a similar image satisfying a check judgment threshold, and an improper judgment result is outputted in a case where there is no similar image satisfying the check judgment threshold in the plurality of images.

In this case, since the check properness can be confirmed one by one by successively comparing the plurality of photographed images with the information concerning the registration images memorized in the memory means, in the case of the photograph object which has been registered, an image coincident with the registered image can be obtained without fail.

According to still another aspect of the present invention, a feature is that in a case where an image acquired at the point of time when the button for check confirmation is pressed down is a check poor image, a check is made by using an image acquired in order of timing near the timing of a press of the button from the plurality of images acquired before the press of the button.

In this case, it is possible to make the check in order of timing near the image acquired at the point of time of the press of the button, which is most suitable for the check.

According to still another aspect of the present invention, a feature is that display means for displaying a check state

7

at the time of check is provided.

In this case, since the check state, such as check success, check failure, or the present check times at the time of the check failure, is displayed and guided at the time of the check, a photograph object person looks at the display guide and can immediately made confirmation, and the check processing can be executed while a sense of security is given to the photograph object person.

Here, the photograph object includes a face of a check object person, and the whole and specific portions of various objects.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view showing an image comparison apparatus of the present invention;

Fig. 2 is a diagram showing an image information acquisition curve and a photograph state of a camera;

Fig. 3 is an explanatory view showing a lean angle state of a check object person who uses the image comparison apparatus of the present invention;

Fig. 4 is a control circuit block diagram of an image comparison system of the present invention;

Fig. 5 is a flowchart showing a check processing operation using the image comparison system of the present invention;

Fig. 6 is a flowchart subsequent to Fig. 5;

Fig. 7 is a schematic side view showing a use state of a conventional image comparison apparatus; and

Fig. 8 is a diagram showing an image information acquisition curve and a photograph timing of a camera when a photograph is taken by the conventional image comparison apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be hereinafter described in detail with reference to the drawings.

The drawings show an image comparison apparatus installed at an image acquisition side of an image comparison system in which a face of a person is photographed and is checked, and in Fig. 1, this image comparison apparatus 11 is constructed by installing an operation panel 12 having a check data acquisition function on a door surface which is used for entrance and exit.

The above operation panel 12 is attached at a position of height of a face of a person, an illumination device 13 for illuminating the face is disposed at its upper portion, a camera 14, a person detection sensor 15, a check result display LED 16, a check count display LED 17, and a check start button 18 are disposed at its intermediate portion, and a personal identification key 19 and a card reader 20 are disposed at its lower portion.

9

In the illumination device 13, a plurality of illuminating LEDs are arranged, and illumination is made toward the forward position of the face height. By this, the roughness state of a face of a person approaching the camera 14 is clearly illuminated to raise the face image acquisition performance of the camera 14.

The foregoing camera 14 photographs a face image by using a CCD camera or the like, and when a person approaches the front of the camera 14, the person detection sensor 15 such as a reflection type infrared sensor detects the approach of the person, the camera 14 starts to photograph from the point of time of the detection, and a plurality of face images of the same person are photographed as a complement until the check start button 18 is pressed down.

Even if a check poor image is produced in an image acquired at a timing when the check start button 18 is pressed down, for the purpose of making a check using a complementary image acquired at a timing before that, the plurality of images as the complement are acquired.

Thereafter, when the check start button 18 is press down, it is judged to be a check request of a check object person and the check is started. At this time, a check result of consistence or inconsistence of the check object person who was checked, is displayed on the check result display LED 16. The check result display LED 16 is designed such that a light

10

of a blue or red judgment result is turned on at one of two LEDs of different colors to enable recognition at a glance.

Besides, at the time of the check, a check state, for example, a first check, or a second or third check due to failure of a check, is displayed in real time by the check count display LED 17 including a plurality of LEDs, so that the check object person is made to clearly recognize it.

Like this, it is possible to recognize the check properness by the lighting display of the check result display LED 16 and it is possible to grasp the check state by looking at the display guide of the check count display LED 17, so that the check object person can execute the check processing at ease without having a distrust or a sense of unease at the time of the check use.

The person detection sensor 15 uses, for example, a light emitting diode for irradiating infrared rays as a light source, and has a reflection type distance detection function to detect the existence of the check object person by detecting reflected light of the infrared rays.

At the foregoing check use, not only the check start button 18, but also the personal identification key 19 may be used, or the card reader 20 may be used, and further, these may be used together.

Among them, the personal identification key 19 and the card reader 20 have an independent check function, and if the

check object person inputs the previously given personal

identification number for identifying the person in question

by using the personal identification key 19 and check

confirmation is made, the door for the entrance and exit use

is unlocked. Besides, if the card reader 20 is used, when ID

data of a card in which the ID data for identifying the check

object person in question is memorized is read out, the door

is unlocked.

Fig. 2 shows an image information acquisition curve 21

when the camera photographs the face image of the check object

person, and the image information acquisition curve 21 shows

that at the timing when the check start button 18 is pressed

down, the face information of the check object person can be

obtained most accurately and the stability of the image is

high.

When the face image is acquired, in the period from the

detection of the check object person by the person detection

sensor 15 to the press of the check start button 18, the camera

14 photographs the face image of the check object person plural

times and acquires the images, and in the case where the check

start button 18 is pressed, at least one of the plurality of

acquired images is compared with information concerning

previously memorized registration images.

At the comparison of the images, a proper judgment result

is outputted in the case where there is a similar image satisfying

12

a previously determined check judgment threshold, and an improper judgment result is outputted in the case where there is no similar image satisfying the check judgment threshold in the plurality of images. Thus, if the plurality of images concerning the same check object person are used on the screen for check judgment, check confirmation with high accuracy can be made, and in the case of the registered check object person, an image coincident with the registered image can be obtained without fail.

As a result, even if the expression of the face at the point of time when the check start button 18 is pressed down is changed as compared with that at the normal time and is judged to be a check poor image, a recheck can be made by using the plurality of images before that.

Particularly, since the check object person of the same person is photographed plural times and the plurality of face images are obtained, the check confirmation can be made by any of the images, and the check processing can be completed by one button press operation without troubling the check object person.

When the plurality of acquired images of the same check object person are checked, a last image 23 acquired in order of timing near a button press timing 22 is used to make the check. By this, the check can be made in order of timing near the image acquired at the point of time of the press of the

13

button, which is most suitable for the check.

Accordingly, as shown in Fig. 3A, in the case where the face of the check object person 31 is directed toward the front, an image suitable for the check can be obtained. On the other hand, in the case where the face of the check object person 31 is directed obliquely upward as shown in Fig. 3B, or in the case where it is directed obliquely downward as shown in Fig. 3C, a slight lean angle θ is produced in the eyes with respect to a front camera 32. When the lean angle is $\theta = 0°$, the image becomes most stable, and when it exceeds $\theta = 15°$, a feature amount of the face can not be accurately calculated, and the image becomes unstable.

Accordingly, when only one image at the time of the press of the button is used, limitation occurs in the check processing. Therefore, the check is complemented by an after-mentioned control processing.

Fig. 4 is a control circuit block diagram of an image comparison system, which is constructed by an image comparison center apparatus 41 for controlling the respective instruments provided on the operation panel 12 of the image comparison apparatus 11, and a CPU 42 of the image comparison center apparatus 41 controls respective circuit devices along a program stored in a memory 43, and the control data is memorized in the memory 43.

An image capture 44 acquires an image photographed by

14

the camera 14, and causes this to be memorized in the memory 43. Besides, the acquired image is displayed on a monitor 46 for monitoring through a display control portion 45.

A first input/output control portion 47 controls respective input/output data of the illumination device 13, the person detection sensor 15, the check result display LED 16, the check count display LED 17, and the check start button 18, and a second input/output control portion 48 controls input from a keyboard 49 for an entrance and exit monitor room.

An RS232C communication portion 50 has a communication connection function to transmit input data from the card reader 20 and the personal identification key 19 to the CPU 42.

A registration file 51 is provided as a data base file at the time of registration of a face image, and data of the face image feature amount of respective registered persons are stored here.

The CPU 42 checks the face image information of the check object person photographed by the camera 14 against the previously registered registration information, and judges the consistence or inconsistency of the check object person, and on the basis of a judgment result checked at this time, the permission of entrance and exit or the restriction of entrance and exit is carried out.

Besides, the entrance and exit state is monitored by the monitor 46 connected to the image comparison center apparatus

15

41, and the data input and the opening control of the door by a supervisor are allowed using the keyboard 49.

A processing operation when a check use is made by using the image comparison system constructed in this way will be described with reference to flowcharts of Figs. 5 and 6.

Now, when a person who makes an entrance and exit use approaches the door of a room provided with the image comparison apparatus 11, the person detection sensor 15 first detects and confirms this (step n1).

At this time, on the basis of a detection signal of the sensor 15, the camera 14 starts to photograph (step n2), and an image obtained by this camera 14 is stored in the memory 43 of the image comparison center apparatus 41 (step n3).

At the time of the image acquisition, after one face image is acquired, a next face image is photographed each time a time necessary for grasping a change in the eyes and direction of a face elapses (step n4).

A photograph is repeatedly taken until the check object person coming in front of the camera 14 presses down the check start button 18, and a plurality photographs are taken. It is preferable that an upper limit of the number of acquired photographs is fixed, so that a photograph is not unnecessarily taken. When the check object person presses down the check start button 18 (step n5), the CPU 42 acquires an image of the check object person immediately after the press of the

16

check start button 18 (step n6).

The CPU 42 compares and checks the acquired face image with previously registered face images, and judges the degree of similarity. At the judgment, the face feature amount of eyes, a nose, a mouth or the like which becomes features at the check time is extracted and are checked (steps n7 to n10).

If the check judgment results in consistence, the check result display LED 16 displays the consistence by lighting (steps n11 to n12), and the check count display LED 17 displays that the check processing is the first and that the check result is the consistence (steps n13 to n14), and at the same time, the door for entrance and exit is unlocked, and the entrance and exit of the check object person is permitted (step n15).

On the other hand, in the case where the CPU 42 judges that the check is impossible, an automatic check judgment is repeatedly carried out within the limit of the previously determined number of check times (step n16).

For example, when the image acquired immediately after the press of the check start button 18 is checked, and when it is judged to be a check poor image since the check object person closes the eyes, opens the mouth or looks away, it is different from the registration image, so that the CPU 42 makes a judgment of improper judgment result, and the check result display LED 16 displays check processing failure by lighting (step n17), and at the same time, the check count display LED

17

17 displays and guides how many times the check processing has been repeated (step n18). At the time of the recheck, after the lights of the check result display LED 16 are put out (step n19), the CPU 42 extracts an image at a timing of one timing before the point of time of the press of the button among the plurality of acquired images of the same check object person and starts to recheck (step n20).

If the consistence is not obtained though the recheck is made, the recheck is further made by using the acquired image in order of timing near the timing of the press of the button. If the consistence is not obtained for all that, a similar recheck operation is repeatedly carried out, and when the number of operations reaches the previously determined check limit number of times, another check means is shown, and if the check object person inputs the personal identification number by using the personal identification key 19, or if the card reader 20 is used to read the card data and check confirmation can be made, an entrance and exit gate is unlocked and the entrance and exit is permitted (steps n21 to n22).

However, in the case where the check confirmation can not be made even if the number reaches the previously determined check limit number of times, or in the case where the improper judgment result is obtained even if the personal identification key 19 or the card reader 20 is used, the improper judgment

18

result is displayed on the check result display LED 16 and
the restriction of entrance and exit is made (steps n23 to
n24).

In the correspondence of the present invention and the
constitution of the foregoing embodiment, the photograph means
of the present invention corresponds to the camera 14, 32 of
the embodiment, and similarly in the following, the photograph
object corresponds to the check object person 31, the button
for check confirmation corresponds to the check start button
18, the object detection sensor corresponds to the person
detection sensor 15, the memory means corresponds to the memory
43 or the registration file 51, and the display means corresponds
to the check result display LED 16 and the check count display
LED 17. However, the present invention can be applied on the
basis of the technical concept recited in the claims, and is
not limited only to the structure of the foregoing embodiment.

According to the present invention, even if a proper check
image can not be obtained at the point of time when a button
for check confirmation is pressed down, check confirmation
can be made by using another image, so that it becomes unnecessary
to repeatedly press down the button, and a check processing
can be completed by one button press operation.